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JPRS: 2702

23 May 1960

MAIN FILE

19981210 060

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THE PRODUCTION OF MACHINEBUILDING  
PRODUCTS AT SHIPBUILDING PLANTS

USSR

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205 EAST 42nd STREET, SUITE 300  
NEW YORK 17, N. Y.

JPRS: 2702

CSO: 4039-N

SIMPLIFYING THE TECHNOLOGICAL PREPARATION FOR  
THE PRODUCTION OF MACHINEBUILDING  
PRODUCTS AT SHIPBUILDING PLANTS

[This is a translation of an article written by V.V. Tsarinikov in Sudostroyeniye (Shipbuilding), No 5, 1959, pages 38-43]

At shipbuilding plants a considerable volume of the work in building vessels is being accomplished by machinebuilding shops (foundry, forging, mechanical working, and mechanical erection). The diversity in the nomenclature of the products made by these shops, their large number necessary at different stages in the construction of a vessel, varying labor consumption, and the difference in the technological processes of the manufacture of these products extremely complicate the preparation of production as well as the planning of the work of the machinebuilding shops.

The volume of operations in machinebuilding items is constantly increasing and, for some types of vessels at the present time, the specific value of the labor of these operations increased from 13-14 percent to 20-22 percent in the total labor of building a vessel. This is assured by an improvement in the preparation of production, reduction in the time of development of the design and planning-technological documentation for products of the machine-construction unit (MSCH) and also the maximum utilization of the capacities of machinebuilding shops by the adoption of group processing of parts, modernization and restoration of the machine part, and the creation in these shops of product-closed specialized sections.

At one of the shipbuilding plants in order to improve the preparation of production, a new simplified system of planning-technological documentation for ordering machinebuilding products has been developed and adopted. The new system assured the fulfillment of the following requirements:

1. Elimination of repeated development of duplicating documentation for products of the MSCH, which were made in accord with normalized drawings and which were used for a number of orders.
2. The creation of a system of planned units -- prepared complexes -- which assures uniformity of their planning in shops and divisions of the plant administration.

3. Grouping of products according to uniform design and technological features under the conditions of the accepted technology of making products of the MSCH.

4. The classification of the products and the numeration of prepared complexes in accordance with the classifier of technical documents in shipbuilding (sections A and B), confirmed by the State Committee on Shipbuilding of the Council of Ministers USSR.

Prior to the introduction of the new system of documentation, the plant accomplished mass building of a small number of types of vessels.

In order to plan the work of the machinebuilding shops, the technological bureaus of the plant developed for each series of vessels shop nomenclature stage records on the production of products of the MSCH. These records, prepared for each participating shop of the work, contained the nomenclature and the number of machinebuilding products which comprise a definite technological stage of the construction of a vessel (Table 1).

On the basis of these records, the technological bureau of the plant, in its turn, prepared at first shop detail norms of the consumption of materials for the total number of products of the MSCH as applicable to each order (Table 2) and then summary specified norms of the consumption of materials for each shop (with breakdown by stages), which were made in the form of material records.

In the nomenclature records which contain the route of the production of the products and the labor involved in each shop, each designation of the product or part, with its assigned constant number position were accepted by the product planning division of the plant as a planning-registration unit. The records were utilized by the product planning division and the shops as the basic planning-technological and norm document for inter-shop operational planning and production registration.

The indicated documentation contained large shortcomings; of these, the following were the main ones:

1. The need to issue for a new series of vessels documentation which is repeated for each design of vessel for products of MSCH, which are made from standardized and general purpose drawings.

2. The lack of classification and grouping of products on the basis of design or technological factors which excludes the possibility of revealing without additional document the volume of the work with respect to single-type products and firming their production in shops of the plant in specialized sections.

3. The cumbersome state of the documentation, the inconvenience of storing and using it. In the case of products made from general purpose and standardized drawings which are repeated for each type of vessel, it was necessary to develop documentation with recalculation of the data in all the columns of the nomenclature and material records for the

number of these products for each design correspondingly. The correction of the documentation, caused by changes in the drawings or the order records, was extremely difficult.

4. The lack in the documentation of any kind of norm-calendar calculations (lots, cycles, rhythms, etc) necessary for the organization of rhythmic production in the shops of the plant.

The new simplified system of planning-technological documentation, as developed and adopted by the technological bureau of the plant, provides for only two documents instead of the documents enumerated above:

- (a) standard detail record compiled for one product made from a standardized drawing, regardless of the number of these products necessary for one vessel and applicable for all the designs;
- (b) warrant-order for machinebuilding products, which contains instructions of nomenclature and the number of products mapped for production (concretely for each design and order).

Below is given a description of the new, simplified technological preparation of production, which was adopted at the plant, for the order of machinebuilding products and the results of its application.

#### Preparing units for machinebuilding products

The introduction of this system was preceded by the creation of preparing units built on the principle of combination of products of MSCH into uniform design groups and their classification in accordance with the technological factors of production.

The preparing units were assigned numbers in accordance with the classifier of technical documents.

The preparing units were developed for products made from general purpose drawings (their grouping is based chiefly on technological factors) and from product drawings the grouping of which is based on design factors.

Moreover, the preparing units of the products made from general purpose drawings encompass such a nomenclature of products, which could be started in production by lots of definite sizes and with the corresponding rhythm of production.

Thus, valves are combined into the unit number 0-520, slides and cocks -- 0-530, cold worked and welded shapes -- 0-553, etc. Products made in accordance with product drawings, for example the anchor unit was given the number 211, the mooring-towing unit -- 212, the boat unit -- 215, etc. Such a system of numeration of the preparing units is convenient in that it is closely related with the numeration of the drawings and technological units of the pier shops. This facilitated greatly the reference of the products of the MSCH to one or another preparing unit and stage in the construction of the vessel.

The preparing units of the products made from product drawings included the machinebuilding products with an indication of their number and nomenclature in the volume of the uniform design group of the technological mounting units of the pier shops. For example, the preparing unit 211 (anchor device) included all products of MSCh, established by the pier shops in the mounting technological units from 211.001 to 211.025.

The product system of preparing units includes the parts of the device, useful products, equipment, and the greater portion of equipment products.

#### Standard detail records

Standard detail records are compiled per unit product of MSCh in order of receipt of the drawings and are gradually supplemented with new designations. Their content reflects entirely the line of production of the parts of the given product in the shops of the plant, the labor or the work of each shop, the norms of the consumption of material per unit product.

Standard detail records (TDR) are developed for products of MSCh without referencing these to any order and are applicable for all types of vessels under construction in the plant. This eliminates repeated processing of the drawings in the technological bureau of the plant and the issue of duplicating documentation in accordance with general purpose drawings having the greatest recurrence for each type of vessel.

The TDR are assigned numbers on the basis of a list of preparing units; moreover, the number of the TDR for valves is given a number, the first two digits of which represent the index of the plant and the next four digits (0.520) -- the number of the design group which is also the number of the preparing unit.

The TDR are issued in accord with a definite form with the addition of a title list, lists containing a schedule of the products, and lists for the introduction of corrections. As the design bureau issues new drawings, the TDR are correspondingly supplemented with individual lists with the mandatory retention of the continuous numeration of the lists and the positions for new drawings within the limits of the given TDR.

In order to compile TDR, use was essentially made of the former form of detail records (Table 2), which corresponds to the position of the order of standardization of the consumption of materials in the shipbuilding industry, with the introduction of additional columns "Departmentalization for producing shops" and "Labor of machine and hand work".

In order to increase the lot characteristics of the products made, during the development of TDR on the product assembly drawing which contains (as a part) the general purpose drawing which has already the TDR, a reference was made in the column "size of billet" to the number of the corresponding TDR with an indication of the list and position with respect to which the given part is recorded.

The reference in the indicated column is made only during the development of the TDR for products made from design drawings. The production of general purpose parts which are components of general purpose assembly drawings is provided directly from these drawings.

The TDR are forwarded to participating shops which make products of MSCh, to the division of materials standardization, and to the group of builders of MSCh.

The TDR serves as a base for the fulfillment of the work in the shops of the plant only when a warrant-order is obtained which contains the number of products made for one or another order. Prior to its receipt the TDR are only a guide for the preparation of production in the shops and divisions of the plant.

#### Warrant-order for the accomplishment of work

A warrant-order (Table 3) is the only planning-accounting document for the production of an order of products of MSCh for all shops and divisions of the plant.

The following serve as the basis for the compilation of a warrant-order:

- (1) TDR issued with consideration of a breakdown into preparing units:
- (2) order records of the central design bureau or lists of ready products, which are developed and issued by the design division of the plant and contain a list of drawings with an indication of the complete number and nomenclature of products of MSCh, which are subject to production in one order.

In order to increase the lot status of products of MSCh during the compilation of order records, the design division observes the following rules: upon receipt of assembly design drawings (local cisterns, reservoirs, branch pipes, etc.), all products which enter these as parts and pass on general purpose drawings (flanges, weldments, pipe connections, etc.) are included in the total summary number of products made from general purpose drawings and indicated in the corresponding order records. In ordering products from general purpose assembly drawings, their parts which also pass on general purpose drawings are not included in the total summary number of order records because these are ordered from assembly drawings.

In this case, the effectiveness of the unit production of the product from the general purpose assembly drawing is greater than that obtained from an increase in the lot status.

The form of the warrant-order is filled in in the following order: number of design, number of order, number of stage, and number of preparing unit. In determining the stage, it is necessary to consider that, in order to create the necessary excess, the production of

products of MSCh should be referenced to the stage preceding that in which the given product is established or mounted on the vessel. Moreover, if single-type products made from one preparing unit are repeated in several technological stages in the construction of the vessel, then the work for making their complete number by order is included in the initial stage with an indication in the warrant-order of the number of products of the optimum lot of MSCh, which are subject to simultaneous initiation.

The numeration of the warrant-orders consists of three groups of digits: the first three designate the type (design) of the vessel, the fourth (Roman numeral) -- the stage and the next three -- the index number of the warrant within the limits of the given type of vessel and stage, for example, 270-V-012.

The warrant-order is filled in in the following order: the index numbers are placed in the first column; the number of the assembly drawing or of the general type of the products of MSCh in the second column; the name of the product or mechanism in the third column; the number of parts of the products or mechanisms on order corresponding to the number indicated in the order record -- in the fourth column; the numbers of the lists and the numbers of the positions of the TDR -- in the 5th and 6th columns; in the 7th column is the labor for the participating shops (for the entire number of products indicated in column 4), which is obtained by multiplication of the labor in the TDR for making one product by their total number. The number of the issuing shop of finished production is taken in a "conditional circle".

The warrant-orders are made out only for products which enter into one TDR. The issue of warrant-orders for products which enter into different TDR is not permitted.

In the warrant-orders for the production of products in accordance with the design drawing which contains general purpose parts (ordered according to the reference in the column 12 of the TDR as assembly parts with respect to other TDR and warrant-orders, in total lots on the vessel), a remark is made with reference to the number of the warrant-order by which these products were already ordered. This applies also to products of interplant cooperation, which are furnished by the division of ship equipment.

After processing all the drawings and the issue of the warrant-orders, the latter are brochured by stages and producing shops for each order, forming portfolios of the work of the participating shops, in accordance with which the product planning division accomplishes operational planning by including the corresponding numbers of warrant-orders in the monthly plans of the shops. The order of their inclusion is determined by the technological stage columns for each vessel order; moreover, the production of products of MSCh is planned with a lead of one stage.

Taking into consideration that the reference of the preparing units during the copy of the warrant-orders is also made one stage earlier than this product is mounted on the vessel, the minimum extent of ready products of MSCh in the warehouses of the plant assures a two-month requirement in the production of these products.

In connection with the use of the new forms of documents, there was a decrease in the total number of documents.

The reduction in the number of documents for one of the orders is characterized by the data in Table 4.

#### Organizational rearrangement of the machinebuilding shops

Simultaneously with the introduction of the new system of development of documentation for the production of products of MSCh, an organizational rearrangement of the production sections was accomplished in the machinebuilding shops.

In the shop for the production of useful products and devices, instead of sections which operate on the principle of "by order", four specialized sections were organized: No 1 -- to make preinsulation equipment; No 2 -- useful products and devices; No 3 -- products of equipment of buildings; No 4 -- fitting-mounting equipment.

An entirely definite group of preparing units was fixed for each section. For example, section No 2 was assigned units 211, 212, 215, etc. Specialized sections, on the basis of assigned units, have the possibility of starting production of single-type repeating products in lots for all the orders and types of vessels.

Within the specialized sections, specialization was accomplished with respect to the skilled workers and crews with the assignment of preparing units and definite nomenclature of work to these, which made it possible to include a considerable fitting out and to mechanize various manual operations.

The monthly output of the shop and the growth of the production program for the same number of workers increase by 22 percent, the reduction in the cost of comparable production amounted to 6-9 percent.

In the mechanical shop of the plant, work was started on the organization of product-closed sections with rearrangement of the equipment, which will assure the organization of flow lines of production of such mass products as swivel drives, flanges, valves, etc. Only a portion of the work carried out in this direction made it possible to increase the shop output by five percent. According to preliminary calculations, the expected increase in the output, when all the mapped organizational measures and improvements in the utilization of equipment are completed, should amount to 28-32 percent.

## Conclusions

1. Thanks to the utilization of TDR which are compiled per unit product for all types of vessels being built at the plant, there was a sharp decrease in the time spent by technologists of the technological bureau of the plant for the development of documentation. Thus, for example, half the time with the same number of technologists is now being devoted to the development of documentation for products of MSCh for a vessel of medium tonnage.

2. In machinebuilding shops, the work of the planning and technological bureaus of the shops for the grouping of single-type parts has been considerably simplified for the work places and has been reduced to the selection of like general purpose products ordered for the given month for different vessel orders from the TDR and warrant-orders.

3. The experience gained by the plant in the development and inclusion of documentation for products of MSCh in the system of TDR and warrant-orders deserves study and generalization in order to apply it to other plants.

Table 1  
Nomenclature record of the work of stage X

No. in order	Name of product	No. of drawings	No. of parts	Material	Dimensions of billet	Route of parts	Consuming shop	Number of parts	No. of parts per object	Labor in man-hours by shops					Total labor	Remarks
										machine	forging	engin- eering.	welding			
1	2	3	4	5	6	7	7a	8	...	11	12	13	14	...	23	24
121	end cap under collar nut	556-77.013														
	Ring	934-77.002	1	Station 3	Strip	11										
	Bottom	936-77.002	2	Station 3	10×25×550 Sheet	11										
	Handle	933-77.001	3	Station 3	2×170×170 Rod Ø5; l = 140	11										
									3	...	4.5	1.5	3.0	3.0	...	12.0

Table 2

Record of detail norms of stage X

No. in order	No. of drawings	No. of parts	Name of parts	Theoretical weight			Material			Billet										Norm of consumption			Remarks
				of one part	per single unit or product	Name of material	Type or brand	Unified Standard or Specification for material grades	Cipher of nomenclature	Type of Billet	Size of billet	Unit of measurement	Cipher of unit measurement	Number of billets	Number of parts per billet	No. of card of pattern	Weight of billet or unit of measurement kg	Per part or one piece	Per unit or product	Coefficient of utilization	No. of consuming shop	No. of section	
121	556-77.013	3	End cap under collar nut—3 pieces.	0.49	1.47	Steel St. 3	3	GOST* 380-57		Strip	10×25× x1650	kg	2	1	3		3.24	1.08	3.24	0.47	11		1.65 running meters
	934-77.002	2	Ring	0.31	0.93	Station 3	3	GOST* 380-57		Sheet	2×170× x510			1	3		1.41	0.47	1.41	0.7	11		0.087 running meters
	936-77.002	3	Bottom	0.02	0.06	Station 3	3	GOST* 380-57		Rod	Ø 5 l = 420			1	3		0.063	0.021	0.063	0.94	11		0.42 running meters
	933-77.001	3	Handle					GOST* 2590-51													11		
			Electrodes E42					GOST* 2523-51											1.0		11		
			Technical vaseline					GOST* 782-53											0.02		11		

Table 3

Form of warrant—order

Technological bureau of the plant		Order 270	Order No. Stage No. V	Preparing unit No. 511	Warrant for the production of products of the machinebuilding section No. 270--V--012										List 1								
No. In order		Designation	Number per order	No. of list of detail record		No. of position in detail record		Labor in norm--hours by shops										Total lists 1					
1	2			3	4	5	6	13		14					22	24	26						
								engineering	machine	welding	other	lathe shop	milling	drilling	planing	machine	other						
1	511--50-6	nipple	4	32	48					6.0	21									27.0			
		part of 3rd drawing				553 -- ordered in warrant 270 -- III -- 009 shop 24																	
		part of 4th drawing				GS555--39--ready product--M3K intershop cooperation																	
2	511--50--9	tee	6	37	56							24.0		4.0		3.0				31.0			
																				58.0			

Continuation of Table 3

Consumption of material considered	Account of readiness of warrant by shops and orders						For standard detail record No. 52.0511 Water-draining system.
	Shops	Order No.	Order No.	Order No.	Order No.	Order No.	
Primary equipment							Fulfilled
Date of order							Checked
							Issued

Note. \*Number of shop-section

Table 4  
According to old system According to new system

Name of document	number of lists (size A <sub>3</sub> )	amount of paper, B	number of lists (size A <sub>3</sub> )	Amount of paper, B
Summary records	5602	672	—	—
Nomenclature records	11 210	1345	—	—
Material records	6 900	828	—	—
Standard records	—	—	5061	607
Warrant-orders	—	—	800 (size a <sub>4</sub> )	48
Total	23 712	2845	5861	655

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